U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
CENTER FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
CINCINNATI, OHIO 45202

HEALTH HAZARD EVALUATION DETERMINATION
REPORT NO. 74-87-221

INDUSTRIAL PLATERS, INC.
COLUMBUS, OHIO
SEPTEMBER 1975

I. TOXICITY DETERMINATION

It has been determined that chromic acid exposure constitutes a hazard for the employees within the hard chrome area based upon an environmental medical study conducted on November 25-26, 1974.

Several definite effects of chromic acid exposure were noted within this small sized study population. Four men were found to have perforated nasal septa and 2 others to have some degree of septal ulceration. Cutaneous scars resulting from past chrome ulceration were noted in 9 of the 11 employees examined. While the majority of the signs and symptoms of chromate exposure elicited during this study undoubtedly dated back at least several years, there was still evidence that adverse effects are continuing to occur within this plant. As evidence of this, are the five individuals in whom injected nasal mucosa were noted and the 2 men with active septal ulceration. While several workmen who are long-term employees described numerous beneficial changes in ventilation, it is apparent that some adverse effects from chromic acid are still occurring.

Workroom airborne concentrations of chromic acid as measured during this evaluation were well below any existing or recommended standards.

The observations of work practices, including the use of personal protective equipment, the presence of characteristic orange chromate stains on workers' skin and the results of spot tests in the work area suggest that much of the nasal and cutaneous pathology that have occurred and continue to occur within this plant probably result from direct contact with the hexavalent chromate ion rather than through airborne exposure. Obviously, the control of this type of contamination will depend upon the proper utilization of personal protective equipment and in scrupulous personal hygiene.

II. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

Copies of this Determination Report are available upon request from the Hazard Evaluation Branch, NIOSH, U.S. Post Office Building,

Room 508, Fifth and Walnut streets, Cincinnati, Ohio 45202. Copies have been sent to:

(a) Industrial Platers, Inc., Columbus, Ohio
(b) Authorized Representative of Employees
(c) U.S. Department of Labor - Region V
(d) NIOSH - Region V

For the purposes of informing the 9 "affected employees" the employer shall promptly "post" the Determination Report in a prominent place(s) near where affected employees work for a period of 30 calendar days.

III. INTRODUCTION

Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6), authorizes the Secretary of Health, Education, and Welfare, following a written request by any employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

The National Institute for Occupational Safety and Health (NIOSH) received such a request from an authorized representative of employees regarding exposure to chromic acid used in the electroplating processes of the Industrial Platers, Inc., Columbus, Ohio.

The request followed an OSHA inspection and was recommended to the requestor, as well as the company, by the OSHA Area Director.

IV. HEALTH HAZARD EVALUATION

A. Plant Process - Conditions of Use

This establishment limits its activities to industrial plating. Zinc, cadmium, nickel, tin, and chromium plating are carried out. Anodizing and gold, rhodium, and silver plating are also performed upon customer order. The hard-chrome plating area is typical of industrial plating facilities. Phosphoric acid, sulfuric acid, chromic acid, and rinse-water tanks are utilized. Nine production workers and a supervisor are employed in the hard-chrome area. Two shifts are worked in the plant, with 5 production workers on the day shift and 4 on the evening shift. All processes in the hard-chrome area are manual. Seven plating tanks - up to 11.5 feet in depth - are utilized to accommodate the wide range of parts to be plated.

B. Evaluation Design

A combined initial, medical, and environmental survey was conducted

over a 2-day period, November 25-26, 1974, to assess the alleged hazard. Pertinent data was collected from the employer and employee representative; a walk-through inspection was conducted; all employees in the hard-chrome area were interviewed and received physical examinations of the skin, ears, eyes, nose, throat, chest, and heart; environmental air sampling was performed in the hard-chrome area; exhaust ventilation effectiveness was checked; a chemical "spot test" was used to test for the presence of hexavalent chromium on a variety of workroom surfaces; and work practices were observed.

C. Evaluation Methods

1. Medical

A total of 11 men received medical evaluations. This included 9 regular production employees, the area supervisor, and the plating rack builder whose work takes him into the hard-chrome area on several occasions each day. All men were interviewed and received physical examinations of the skin, ears, eyes, nose, throat, chest, and heart. All interviews were begun in a nondirected manner and after soliciting complaints each man was asked about the presence of the following findings or symptoms: nosebleeds, "runny nose," nasal itching, nasal soreness, sore throat, hoarseness, red eyes, tearing, asthma, stomach pain, coughing, chest pain, skin sores, and rash. The following signs were specifically looked for in each individual: dermatitis, chrome holes, old chrome hole scars, injected mucosa, ulcerated nasal septum, nasal reddness, perforated nasal septum, reddened throat, conjunctivitis, wheezing, and other signs of chest pathology.

2. Environmental

Environmental air samples were collected from the breathing zones of all workers in the hard-chrome area and analyzed for hexavalent chromium. Some general room air samples were also collected. All samples were collected using a vacuum pump, which was operated at a flow rate of 2 liters of air per minute.

The samples for hexavalent chromium were collected on 5.0 microns polyvinyl chloride (PVC) filters. A minimum volume of 100 liters of air was collected for each sample. The method of Abell and Carlberg was used to determine the concentration of hexavalent chromium.[1]

The effectiveness of the local exhaust ventilation on the plating tanks was checked using smoke tubes.

While dilute solutions of phosphoric and sulfuric acid are used in various steps of the electroplating process atmospheric measurements for these substances were not performed since in the professional judgment of the investigators they were not deemed to constitute a possible significant airborne hazard.

A chemical "spot test" using a 1 percent alcoholic solution of diphenylcarbazide (DPC) was employed to detect the presence of hexavalent chromium on various surfaces within the plant. The test is performed by immersing an ordinary cotton-tipped applicator into a stock solution of 1 normal sulfuric acid and rubbing the cotton tip vigorously on the surface to be tested. One or 2 drops of the DPC solution is, then, placed on the cotton tip. A more or less intense blue-violet to red color forms in the presence of hexavalent chrome. Work tables, racks, gloves, hoist controls, a drinking fountain, telephones, and workers' fingers were tested for the presence of hexavalent chrome.

D. Evaluation Criteria

1. Environmental Standard

The Occupational Health Standard promulgated by the U.S. Department of Labor (Federal Register, June 27, 1974, Title 29, Chapter XVII, Subpart G, Table G-2) applicable to the individual substance of this evaluation is as follows:

Substance	8-Hour Time Weighted Average	Acceptable Ceiling Concentration
Chromic Acid & Chromates		0.1 mg/m^3*

*Approximate milligrams of substance per cubic meter of air.

Additionally, NIOSH has published the "Criteria for A Recommended Standard...Occupational Exposure to Chromic Acid."[2] The limit recommended in this document is lower for chromic acid than the Federal Ceiling Concentration. It is anticipated that the more restrictive limit may eventually be adopted as the Federal Standard:

Substance	8-Hour Time Weighted Average	Acceptable Ceiling Concentration
Chromic Acid	0.05 mg/m^3*	0.1 mg/m^3 **

*Approximate milligrams measured as chromium trioxide per cubic meter of air.

**As chromium trioxide determined by a sampling time of fifteen (15) minutes.

Occupational Health Standards for individual substances are established at levels designed to protect workers who are occupationally exposed on an 8-hour-per-day, 40-hour-per-week basis over a normal working lifetime. Where the standard is recorded as a ceiling concentration, the level of that substance in the work room atmosphere shall at no time exceed that value.

2. Toxic Effects

In many of the studies done to date, it has been difficult to separate the biologic effects of chromic acid from those of other hexavalent and trivalent chromates. Most of the effects attributed to chromic acid have been observed in studies of workers producing chromic acid, rather than in users of this compound. It should be remembered that the array of signs and symptoms reported for chromate production workers may not be truly valid indicators of toxicity for workers exposed to purely chromic acid. Such exposure, as is in this instance, occurs most commonly in electroplating operations.

A rather wide range of signs and symptoms have long been recognized as occurring in chromate workers. Injection of the cornea has been noted in 39 per cent, and tearing and/or burning of the eyes in 17 per cent, of workers exposed to chromate. Nasal septal ulceration or actual perforation has been noted in a high percentage of chromate workers. This complication is usually preceeded by nasal itching, soreness, and epixtaxis (bleeding).

When examined by various investigators, from 4 to 55 per cent of the chromate workers have had nasal septal ulcerations; and in some studies as high as 56 per cent of workers had actual septal perforation. In addition, the majority of chromate workers are reported to have a chronic rhinitis. These effects upon the nasal mucosa generally occur rather quickly following initial exposure to chromate, and the majority occur in less than a year. The mucous membrane of the throat may also be affected, and severely reddened throats have been reported in 11 per cent of chromate workers. Hoarseness due to irritation of the larynx is said to occur in approximately 10 percent of the chromate workers.

Exposure to the chromate ion in the hexavalent form, such as occurs with chromic acid, results in a rather peculiar and characteristic skin lesion known as the "chrome hole." This is an indolent skin ulcer which characteristically occurs on the hands or other skin surfaces which have come into actual contact with the chromate ion. Such ulcers have been reported in from 10 to 12 percent of chromate workers, although much higher percentages will show scars or other evidence of past skin ulcers. Actual primary skin irritation or al-

lergic contact dermatitis is apparently rather rare, and an incidence of less than 2 per cent has been noted.

The most serious health hazard noted to date for chromate workers has been the high incidence of bronchiogenic carcinoma. The incidence of this almost invariably fatal disease appears to be increased from 10 to 40 times that of the general population. Various studies of such cases have indicated that there is a latent period prior to the occurrence of cancer, varying from about 10 to nearly 25 years. Thus, as would be expected, the majority of such cancers occur in men past the age of 50. To date this extremely serious health hazard has only been noted in employees involved in the production of chromium metal from the reduction of chromium ores. It is thought to be related to the trivalent state of the ion encountered in these situations or perhaps contamination with other elements, such as nickel, which may be carcinogenic. Cancer has not been reported as a problem among electroplaters and others exposed to hexavalent chrome, such as chromic acid.

Both sulfuric and phosphoric acids are classed as very strong irritants, and skin contact may result in serious burns. Fortunately, harmful concentrations of these acids are usually readily detected and thus avoided.

E. Evaluation Results and Discussion

1. Medical Investigations and Results

There is no dispensary or clinic in the plant. Medical coverage is provided by local physicians on a fee-for-services basis. There are no regular provisions for pre-employment or annual examinations. At the request of the union, a number of men in the hard-chrome area have been examined by a local specialist in Ear, Nose, and Throat. The plant receives regular industrial hygiene consultation and services provided by the State of Ohio. There is a safety committee and a monthly safety inspection. Preceeding this evaluation the plant was visited by OSHA, and airborne chromate levels were found to be well within Federal standards. Safety-toe boots are required; and gloves, aprons, and safety glasses are provided by the company.

The employees of the hard-chrome area averaged 39 years of age (range 22-54). The average duration of employment with the company was 9 years and 4 months (range 4-16). Most employees had worked in the hard-chrome area for the majority of their employment. The average duration of employment in this area was 7-1/2 years.(range 3-16).

Four men reported experiencing nose bleeds. In 3, this was prior

to eventual nasal septal perforation. The remaining individual had noted some blood-tinged streaking in recent months upon blowing his nose. The symptom of "runny nose" was reported by 6 individuals. In 2, this was associated with exposure to colder outdoor temperatures. In several, it again preceeded actual nasal perforation. Only 1 individual reported nasal itching, and he "picked at it all the time." Nasal soreness was mentioned as a symptom by 4 men, and in 2 of these, it was related to cold exposure. In 1 individual nasal soreness preceeded ultimate septal perforation. Four men reported reddening of the eyes and tearing on an occasional basis - primarily, when local ventilation systems were temporarily inoperative.

Five individuals described various types of stomach pain or distress. In 2, a duodenal ulcer had been diagnosed, and in 1, gastritis. One individual described frequent "stomach cramps," and another man related frequent bouts of "indigestion."

Five employees related occasional episodes of coughing. Three of these men were moderate to quite heavy smokers, and 1 gave a history of foundry employment for some 7 years before joining Industrial Platers, Inc.

A history of past skin sores was related by 7 men. Only 1 individual gave a history of preceeding dermatitis. In this instance it appeared to be related to occasional caustic exposure.

Examination of the hands revealed that 9 individuals had scars characteristic of healed chrome ulcerations.

Some injection of the nasal mucosa was observed in 5 men, although in 1 this was quite minimal in nature. Active ulceration of the nasal septum was observed in 2 men; and 2 men had atrophic scars of the septum, indicating the presence of past ulceration. Complete perforation of the nasal septa was present in 4 employees. Some minimal injection and redness of the throat was present in 2 men, and 1 man was found to have active tonsilitis and adenititis.

One individual was observed who had some decrease in breath sounds upon chest oscultation, and another was noted to have an increase in the anterior-posterior diameter of his chest. In each of these instances these findings were believed to be related to early emphysema. Among the other miscellaneous findings encountered during the survey were 1 man with chemical diabetes; 1 with early ocular pterygium formation on the corneal conjunctiva; and 1 individual with advanced renal cell carcinoma. The latter workman was first noted to have renal cancer in 1967. This was removed the following year,

and he remained tumor free until 1973 when an apparently metastatic tumor to the remaining kidney was discovered. He is currently undergoing cobalt therapy.

2. Environmental Results:

A total of 17 air samples were collected during the 2-day evaluation, including 14 personal and 3 general room air (area) samples. The results are presented in Table I. The concentrations of the samples ranged from less than < 0.001 mg/M^3 Cr $^{+6}$ to 0.020 mg/M^3 Cr $^{+6}$, with a mean value of 0.004 mg/M^3.

Smoke tube tests showed all local exhaust ventilation systems to be functioning adequately.

Chemical spot tests showed widespread contamination of hexavalent chromium on virtually all surfaces in the hard-chrome area, including work gloves (inside and outside), hoist controls, work surfaces, tools and the drinking fountain, as well as on the hands of 6 of the 9 employees.

3. Conclusion - See Toxicity Determination

4. Recommendations:

a. It is suggested that all employees in the hard-chrome area be required to wear protective gloves at all times when the wearing of such protective gear is not inconsistent with their personal safety. A hand basin containing a 5 percent solution of sodium hyposulphite and located within the work area has been found to be very useful in neutralizing any chromic acid that may have contaminated the skin or hands of those workers not utilizing gloves or in situations when accidental spills have occurred.

b. Workers should be provided with shower-locker room facilities and be required to shower and change to non-contaminated street clothes prior to leaving the plant.

c. The nasal mucosa of workmen can usually be adequately protected by the application of plain petroleum jelly with a cotton-tipped applicator. Such application should be made immediately prior to the beginning of each work shift. An even more effective protective ointment consists of the following: sodium pyrosulfite, 4 grams; tartaric acid, 2 grams; glucose, 2 grams; ammonium chloride, 2 grams mixed into 90 grams of ointment base consisting of propylene, 10 percent, carbowax (4,000) 30 percent, and carbowax (1,500), 60 percent. This formulation, which can be used either on the nasal mucosa or on the skin, has been found to be highly efficacious in the reduction of hexavalent chrome to the non-ulcerogenic trivalent state.

d. Workmen should not be permitted to eat, drink, or smoke in the work area.

e. It is recommended that each man receive an annual physical examination emphasizing the nose, throat, hands and chest. An annual chest X-ray is also recommended. Proper medical management should be provided for all workers with symptoms of skin or upper respiratory tract irritation at the time the symptoms first occur.

V. REFERENCES

1. Abell, M.T., and Carlberg, J.R.: A Simple Reliable Method For The Determination of Airborne Hexavalent Chromium, AMERICAN INDUSTRIAL HYGIENE ASSOCIATION JOURNAL, Volume 35, No. 4, April, 1974, pages 229-233.

2. Criteria for a Recommended Standard...Occupational Exposure to Chromic Acid, 1973, HSM-73-11021.

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TABLE I

Sampling Results for Hexavalent Chromate

November 1974

Shift	Approximate Sample Period	Job	Sample Volume (liters)	mg/M^3 Cr $^{+6}$	Results of Chemical Spot Test On Employees' Hands
Evening	(7-10 P.M.)	A-Plater	194	0.002	Positive
"	"	Tank Operator (Tank #1)	130	0.001	Positive
"	"	Master Plater	136	0.003	Positive
"	"	Tank Operator (Tank #2)	158	0.001	Negative
"	"	Area Near Tank #8	186	<0.001	
"	"	Area Near Tank #14	190	0.008	
Day	(8-10 A.M.)	Polisher	138	<0.001	Negative
"	"	Tank Operator (Tank #1)	122	0.005	Positive
"	"	Tank Operator (Tank #2)	76	<0.001	Positive
"	"	Tank Operator (Tank #3)	80	0.001	Positive
"	"	Master Plater	122	0.012	Negative
Day	(10 A.M.-12 Noon)	Polisher	108	<0.001	
"	"	Tank Operator (Tank #1)	106	0.020	
"	"	Tank Operator (Tank #2)	140	0.001	
"	"	Tank Operator (Tank #3)	146	<0.001	
"	"	Master Plater	146	0.001	
Day	(8 A.M.-12 Noon)	Area Near Tank #14	350	<0.001	